Feeding ecology of juvenile chinook salmon in Lake Washington, 1999

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Unlike most systems in which juvenile chinook rear in rivers and estuaries, juvenile chinook in Lake Washington rear in littoral areas of the lake from January to early June. These shallow littoral areas are highly urbanized, consisting of docks and bulkheads and accompanied by loss of riparian area. The decline of Puget Sound chinook salmon, and their listing as endangered under the Endangered Species Act, suggests that one potential “limiting factor” on juvenile chinook is the effect of such intensive urbanization on juveniles in the lake. To investigate this, we examined stomach contents of juvenile chinook caught in the littoral zone to determine prey composition, and conducted pilot epibenthic and neustonic sampling in the lake to document prey resources available to juvenile chinook.

Preliminary results indicated that juvenile chinook rearing in the littoral zone of Lake Washington primarily consumed dipterans in the family chironomidae (59% prey biomass), but that they switched to feeding on the planktonic crustaceans *Daphnia spp* (27% prey biomass) in late spring/early summer. The fish consumed chironomids primarily as emergent adults, but chironomid larvae and pupae were also consumed. Other crustaceans and terrestrial insects formed a relatively small proportion of the prey. Composition based on abundance and frequency of occurrence basically mirrored prey contribution based on biomass. Chinook caught in the southern part of the lake also ate less *Daphnia* than those caught in the central and north parts of the lake. This finding corresponds to the pattern of *Daphnia* production observed in the lake in 1999, when abundance increased in late May and early June and *Daphnia* numbers were greatest in the north end of the lake.

From April through June, we conducted prey resource sampling over fine and coarse substrates at three sites corresponding to three levels of human impact: (1) St. Edwards Park, an undeveloped naturally forested shoreline, (2) Madison Park, a developed residential shoreline and urban park, and (3) Gene Coulon Park, an intermediately-impacted area with some natural and some developed shoreline. Epibenthic samples, taken by pumping organisms and organic debris from on and above the bottom substrate inside a sampling cylinder, indicated large variances in prey taxa densities. Taxa richness (mean number of taxa per sample) was highest at Gene Coulon Park throughout the sampling. This difference was more pronounced in fine sediments than in coarse sediments. Densities of chironomid larvae varied between sites and substrates, but our data suggests that that coarse substrate may produce more chironomids than fine substrates.

Neuston (organisms associated with the water's surface) was also sampled at the same three study sites. As with epibenthic organisms, densities of neuston prey resources were highly variable among the sites. Taxa richness was greater at St. Edwards Park and Gene Coulon Park sites than at Madison Park, but the differences between April and June were small. Relative densities of chironomids in neuston samples from St. Edwards Park and Gene Coulon Park were higher early in the season, but these differences decreased in June.

We used the results from this pilot study to re-design our sampling in 2000. In addition to continued sampling of juvenile chinook diet composition, we investigated landscape-scale differences between paired residential and forested riparian sites and commercial and marsh sites at the north end of the lake. Our goal is to use the resulting data to evaluate the effects of major shoreline development patterns on prey assemblages of juvenile chinook salmon in Lake Washington that might contribute to population declines.

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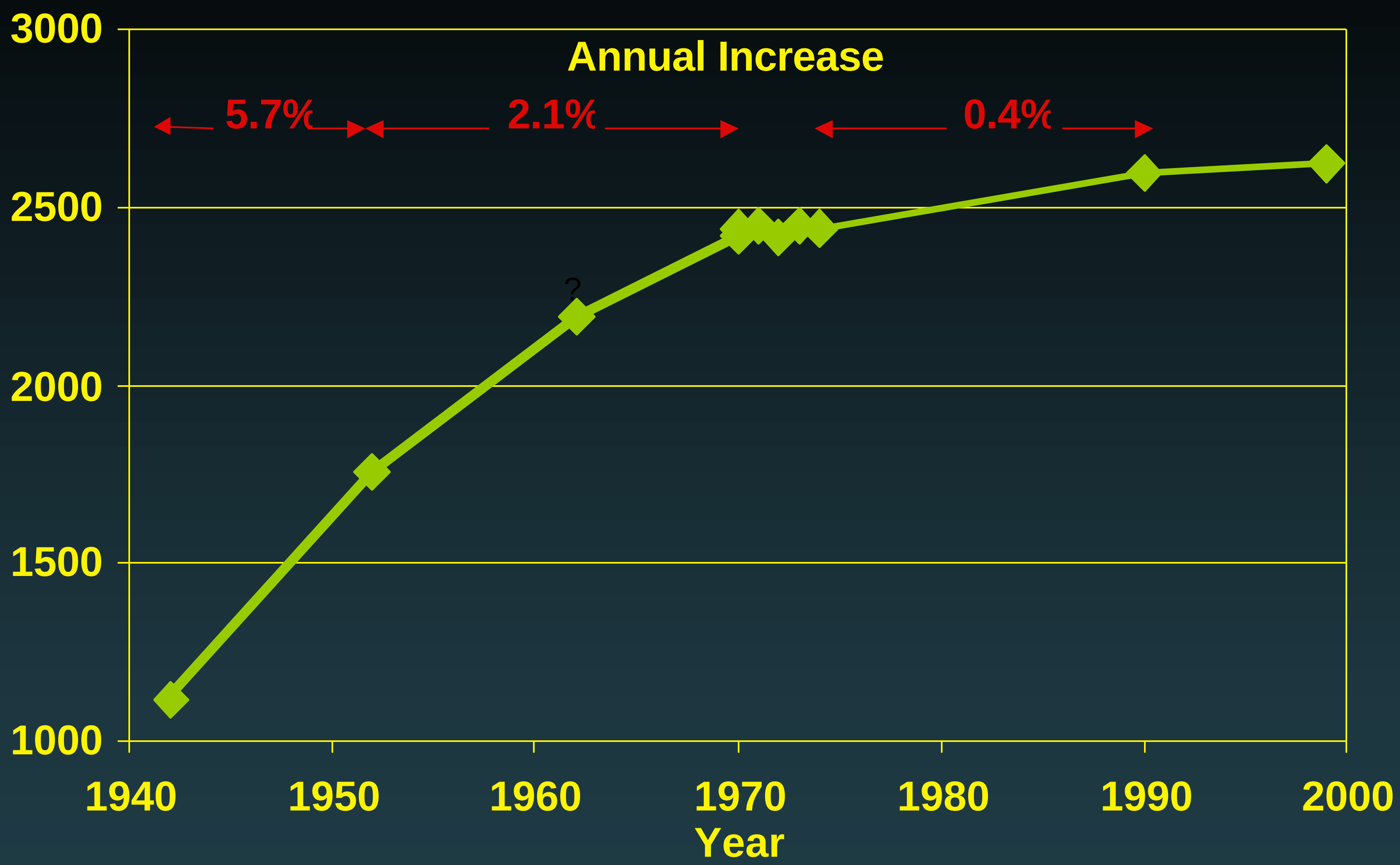
School of Aquatic and Fishery Sciences, University of Washington

c. 1891

Change in the Number of Piers in Lake Washingto



[1] Hockett, C.A. 1976. Urbanization and shoreline development of Lake Washington.

(Figure courtesy of Jason Toft)

Objective

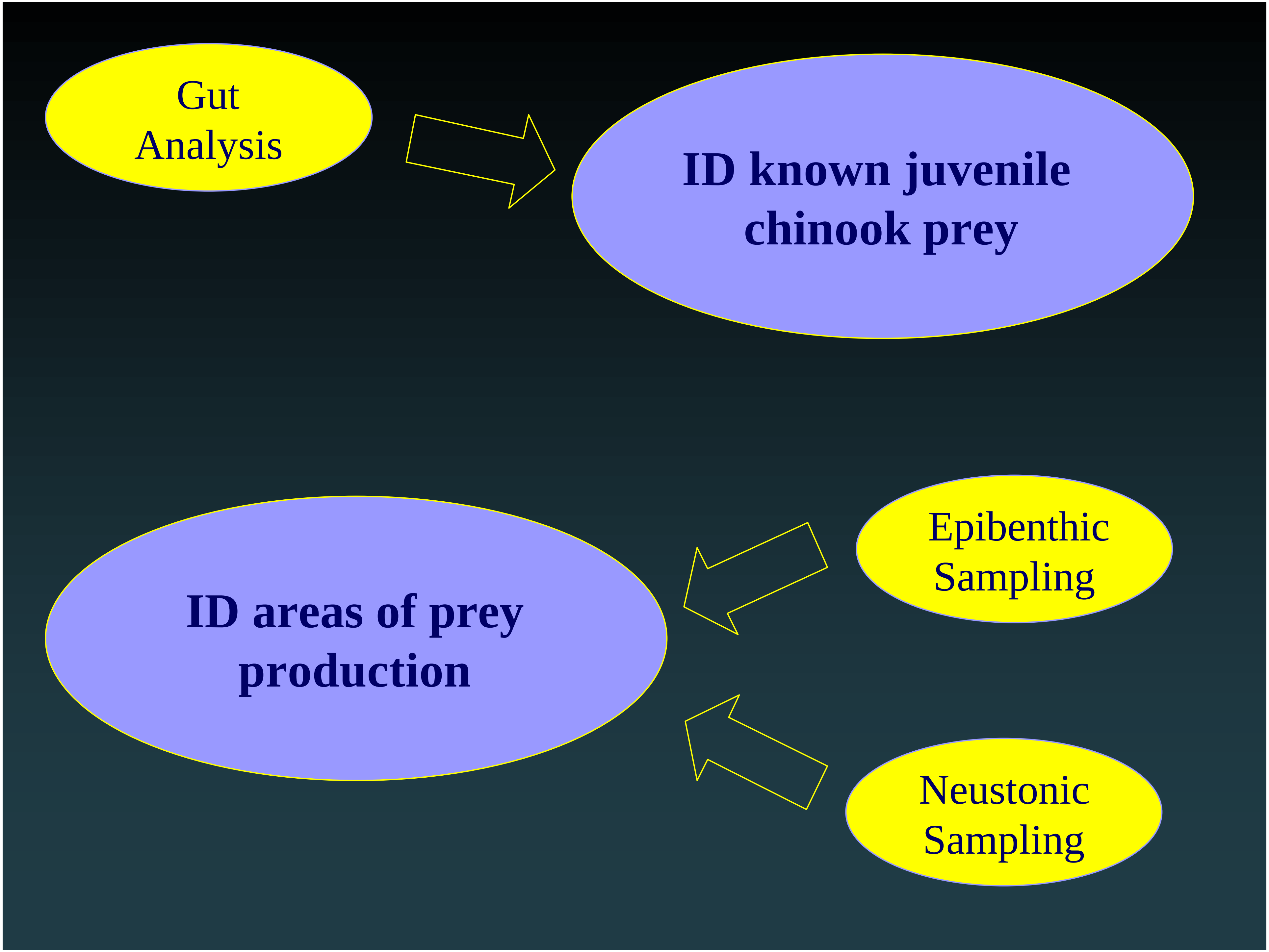
- Establish linkages between lake habitats and juvenile chinook prey in Lake Washington

Hypotheses

- Juvenile chinook feeding in LWA is similar to that in estuaries or reservoirs

Neustonic | Epibenthic

- Low-impact shorelines produce more chinook prey than high impact shorelines in LWA

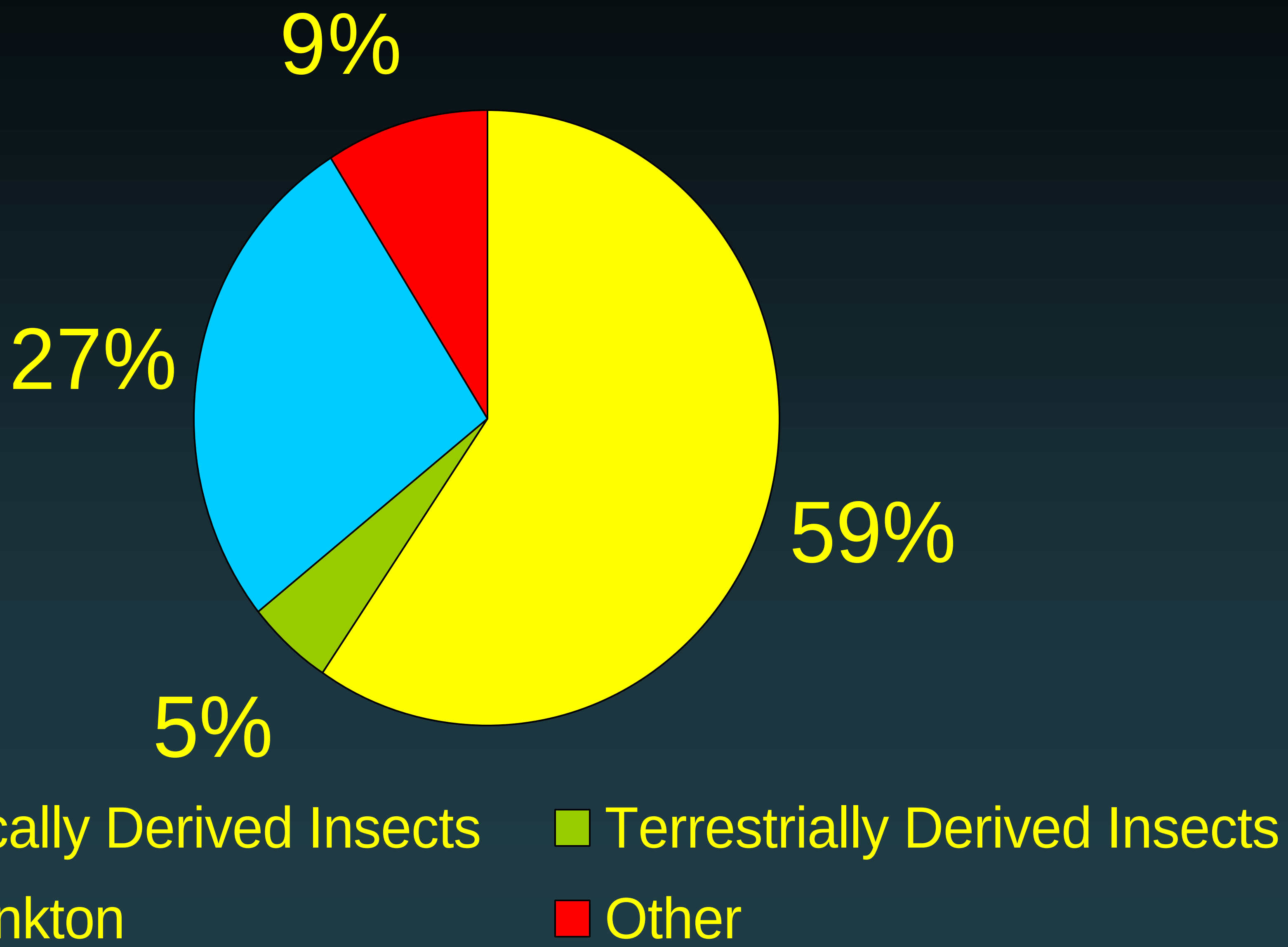

Gut Analysis
ID known juvenile chinook prey
ID areas of prey production
Epibenthic Sampling
Neustonic Sampling

DIET ANALYSIS

(Figure courtesy of J. Hall and R. Timm)

- Beach seines conducted by **WDFW** bi-weekly
- Fish weighed and measured
- Gastric lavage method
- Organisms counted and weighed
- GUTBUGS computer analysis

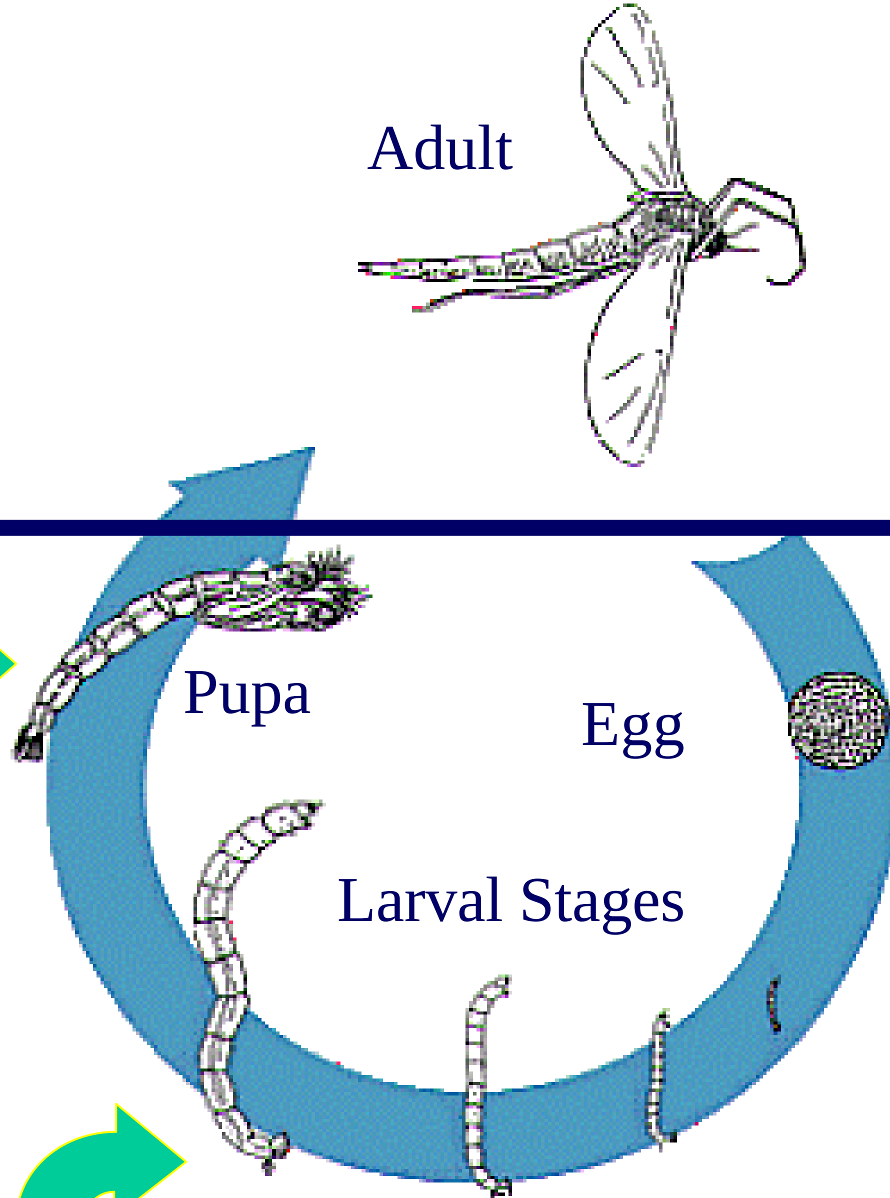
1999 Diet Biomass



Chironomid
(midge)
Life Cycle

Epibenthic/

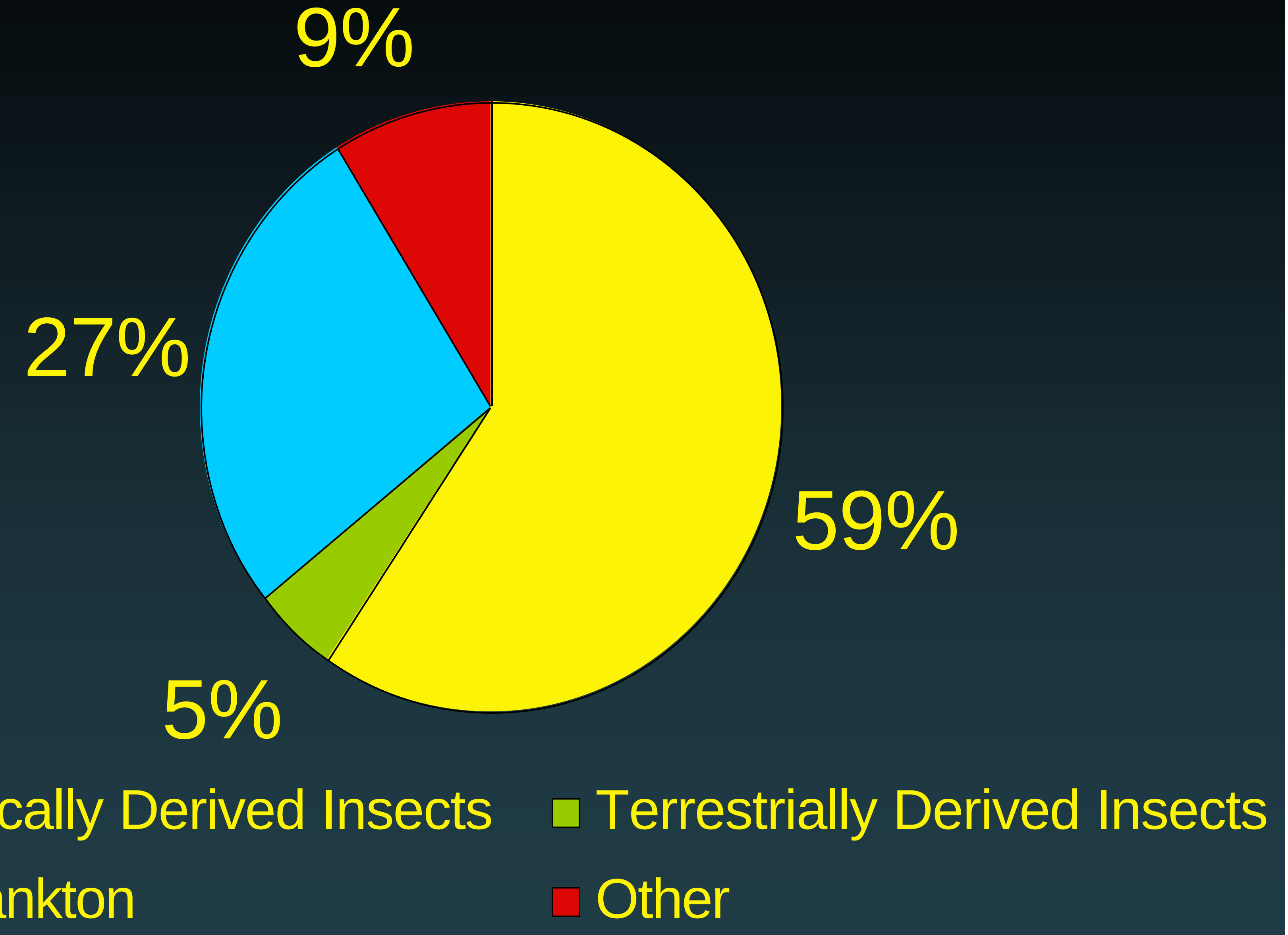
Pelagic

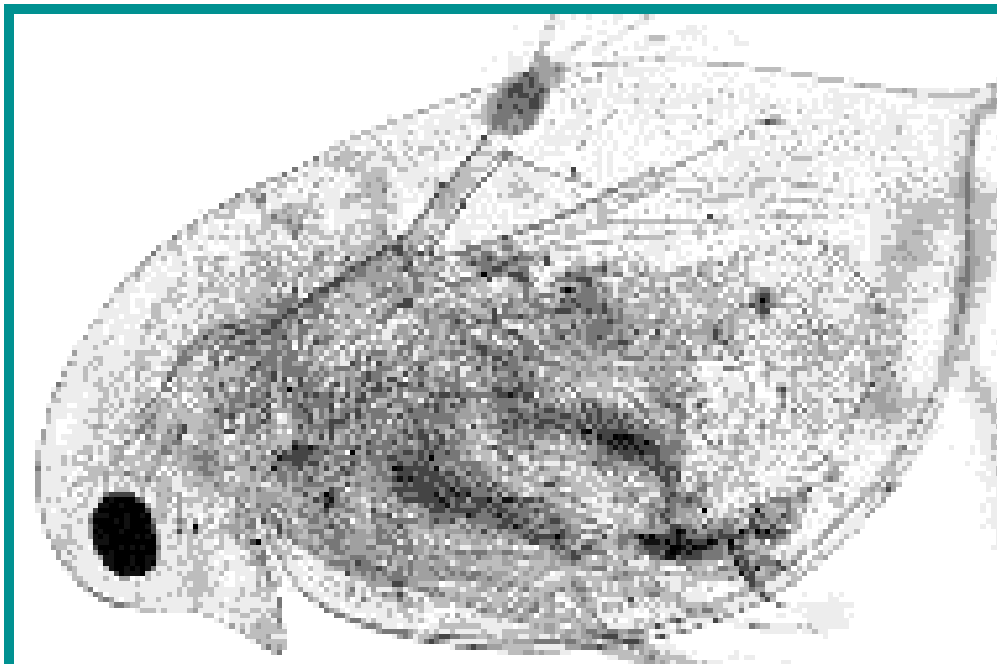


Epibenthic

Photo:www.hi.is/HI/stofn/Myvatn/mycycle.htm

1999 Diet Biomass



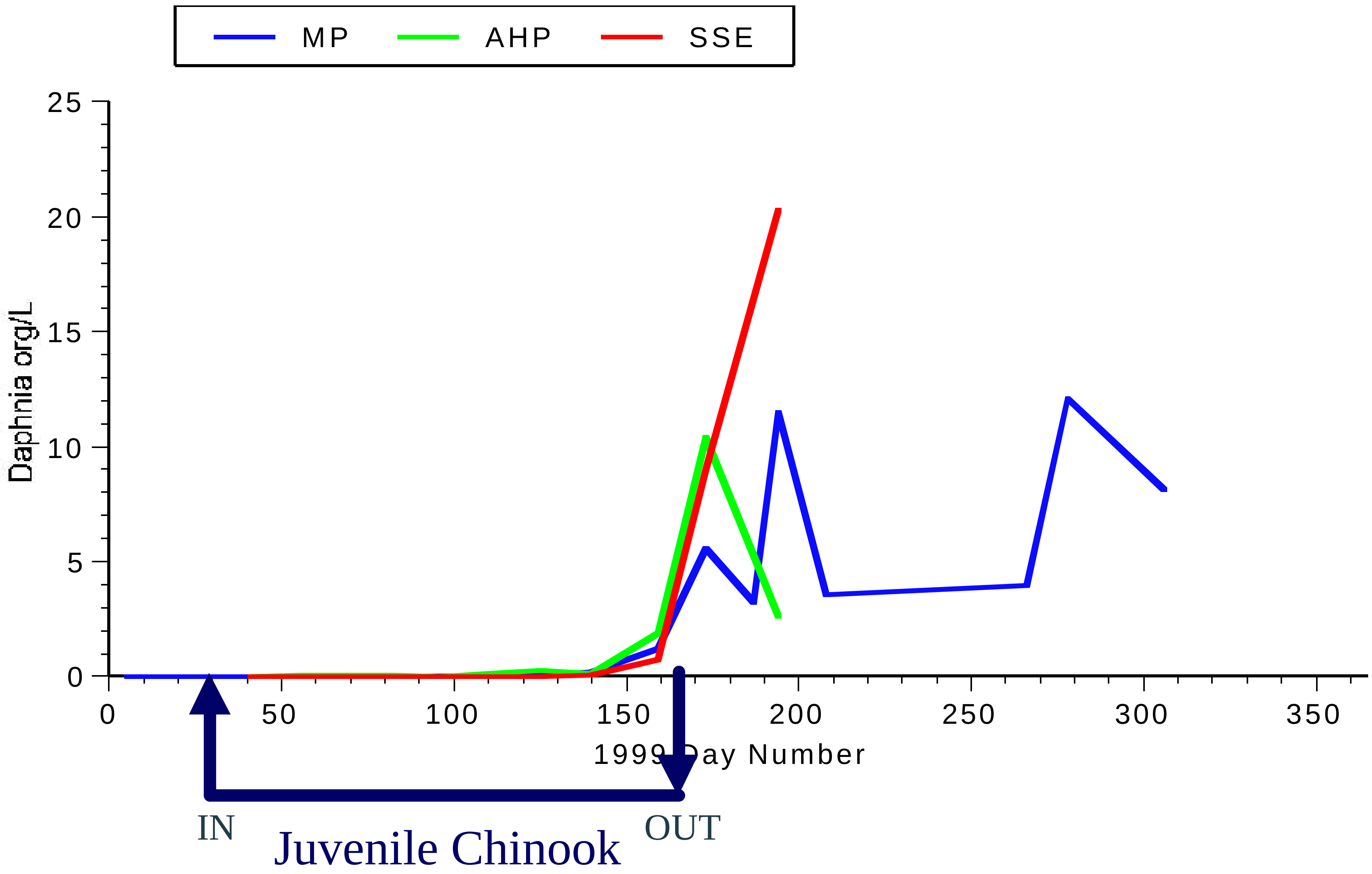


Daphnia
(water flea)

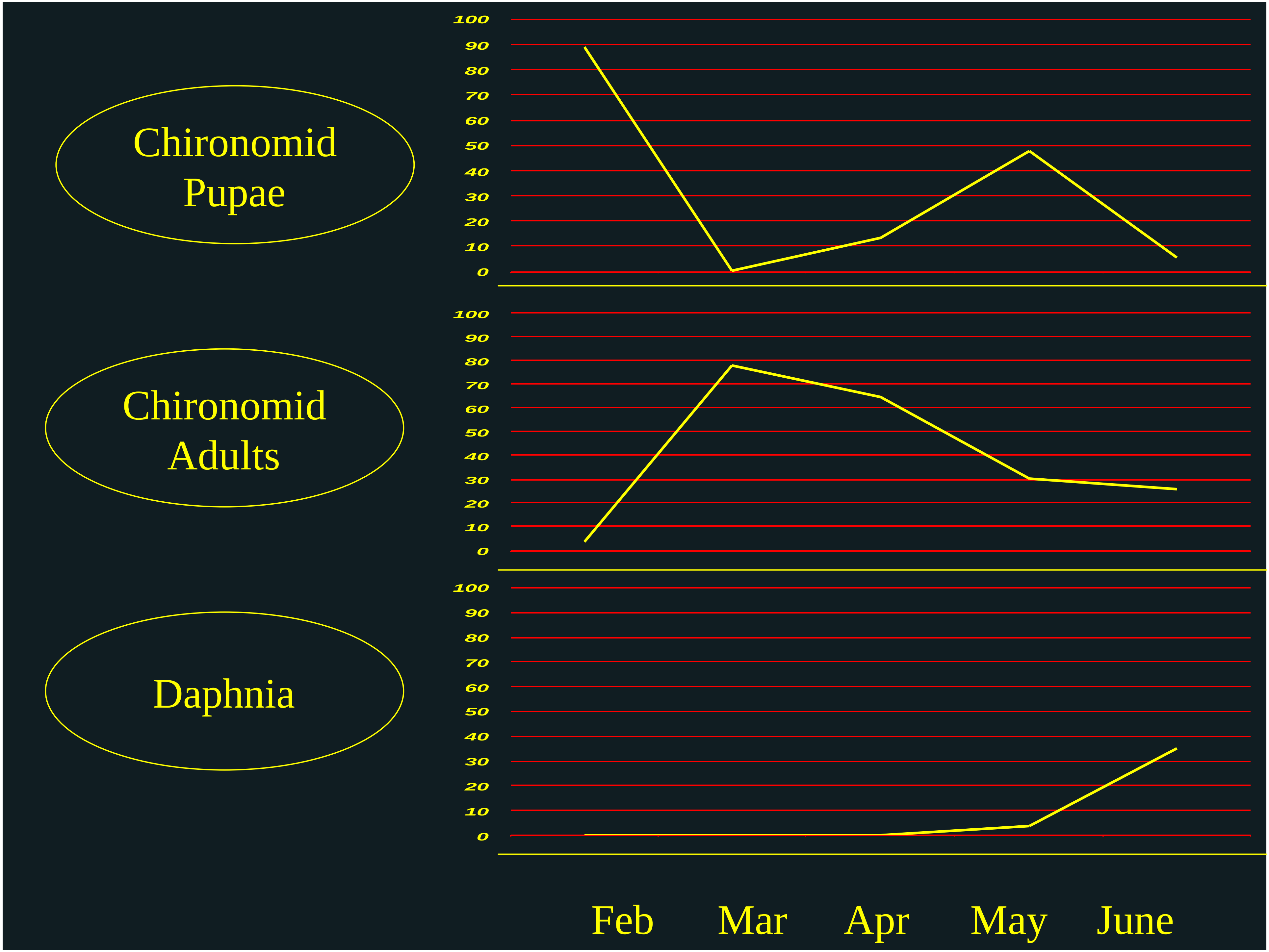
- •Larger than other zooplankton
- •Different species
- •Seasonal Presence in lake

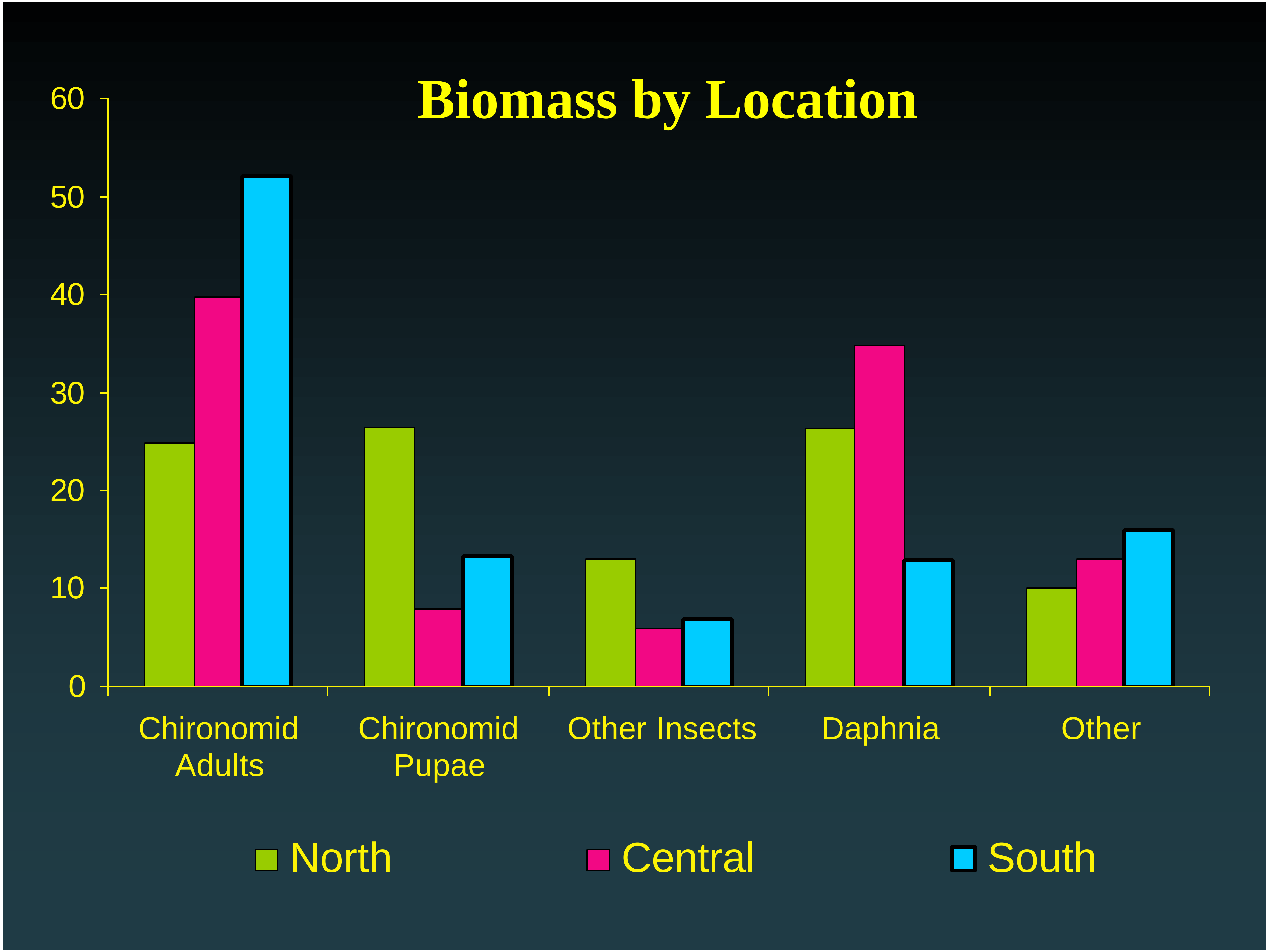
Photos: www.daphnia.com & ebiomedia.com/gall/classics/Daphnia/feature_main.html

Daphnia in Lake Washington



(Figure courtesy of Schindler Lab, UW Zoology Department)


Chironomid Pupae
Chironomid Adults
Daphnia
100
90
80
70
60
50
40
30
20
10
0
Feb
Mar
Apr
May
June


Biomass by Location
60
50
40
30
20
10
0
Chironomid Adults
Chironomid Pupae
Other Insects
Daphnia
Other
North
Central
South

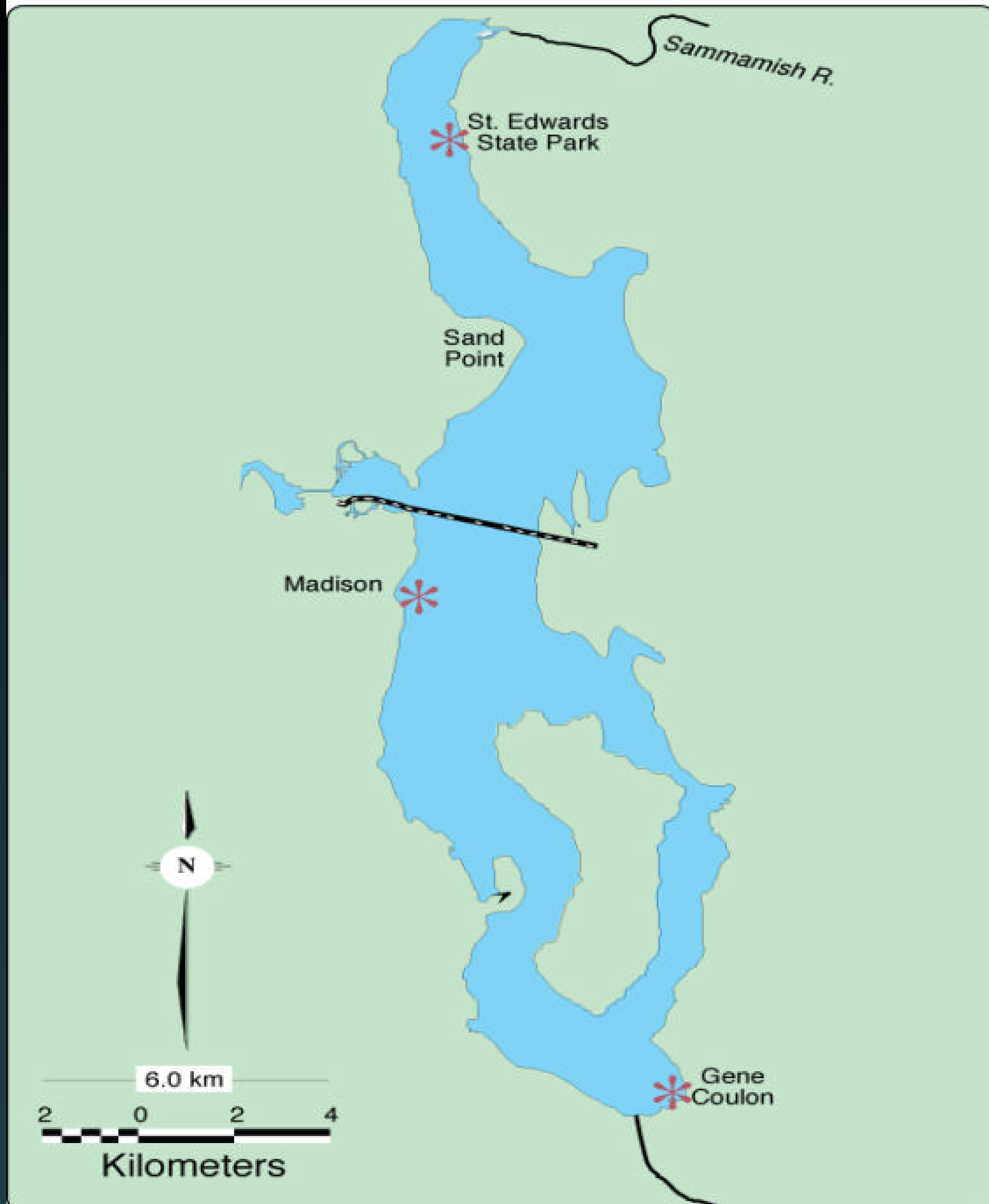
Diet Analysis

- Juvenile chinook feed on midges; later in the season, Daphnia
- Chinook picking both prey types out of the water column or off of the lake's surface (little benthic feeding)
- Chironomid life cycles utilize epibenthic, pelagic, neustonic strata
- Feeding follows daphnia production

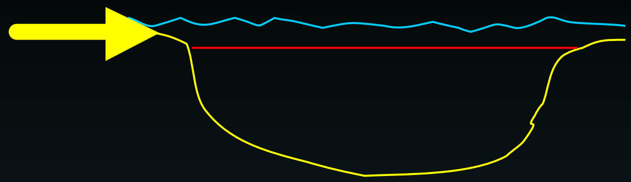
St. Edwards Park

Gene Coulon Park

Residential areas



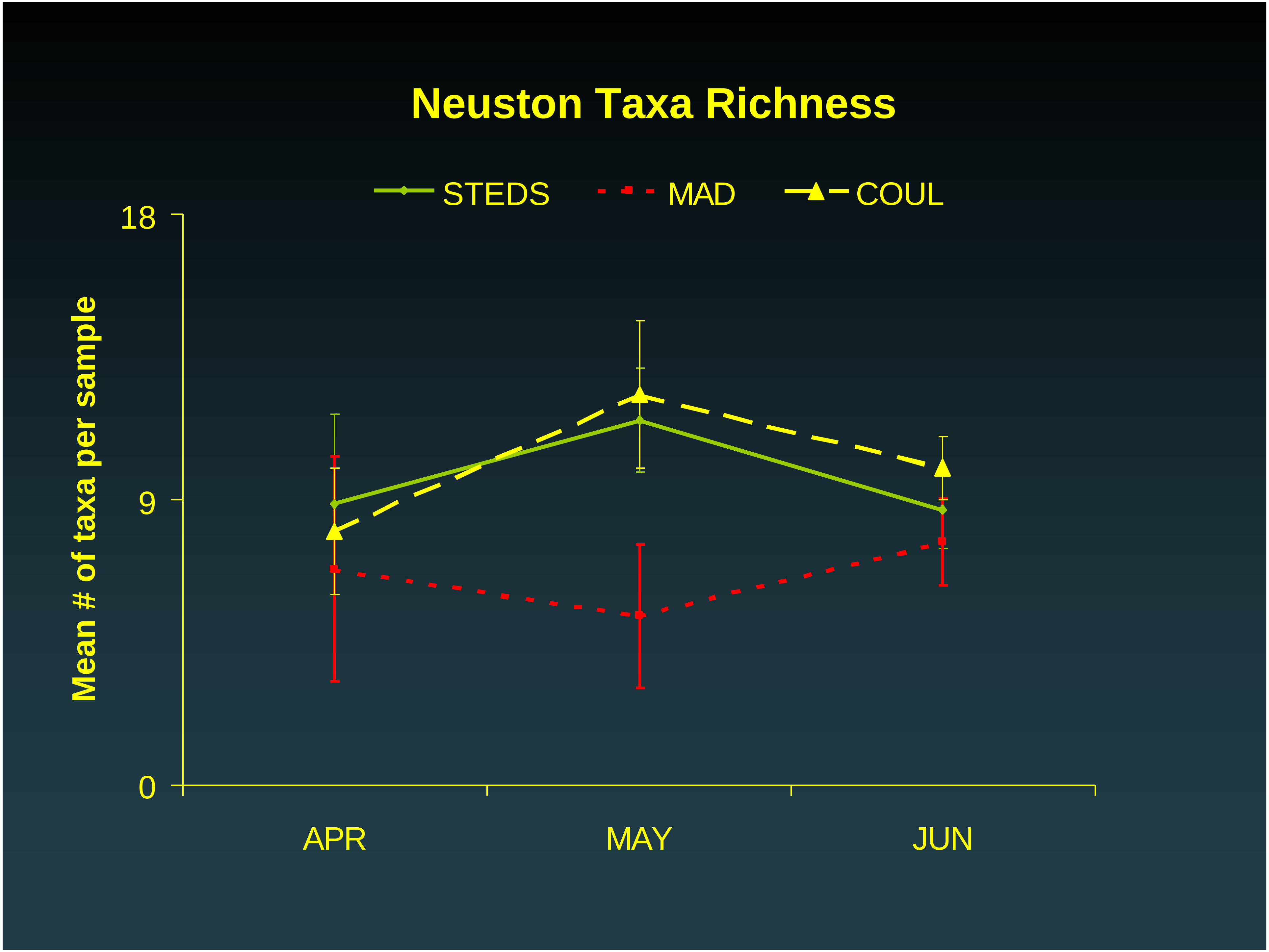
Sammamish R.
St. Edwards State Park
Sand Point
Madison
N
Gene Coulon
6.0 km
2 0 2 4
Kilometers



Neuston Methodology

Sampled every third week

3X, perpendicular to shore



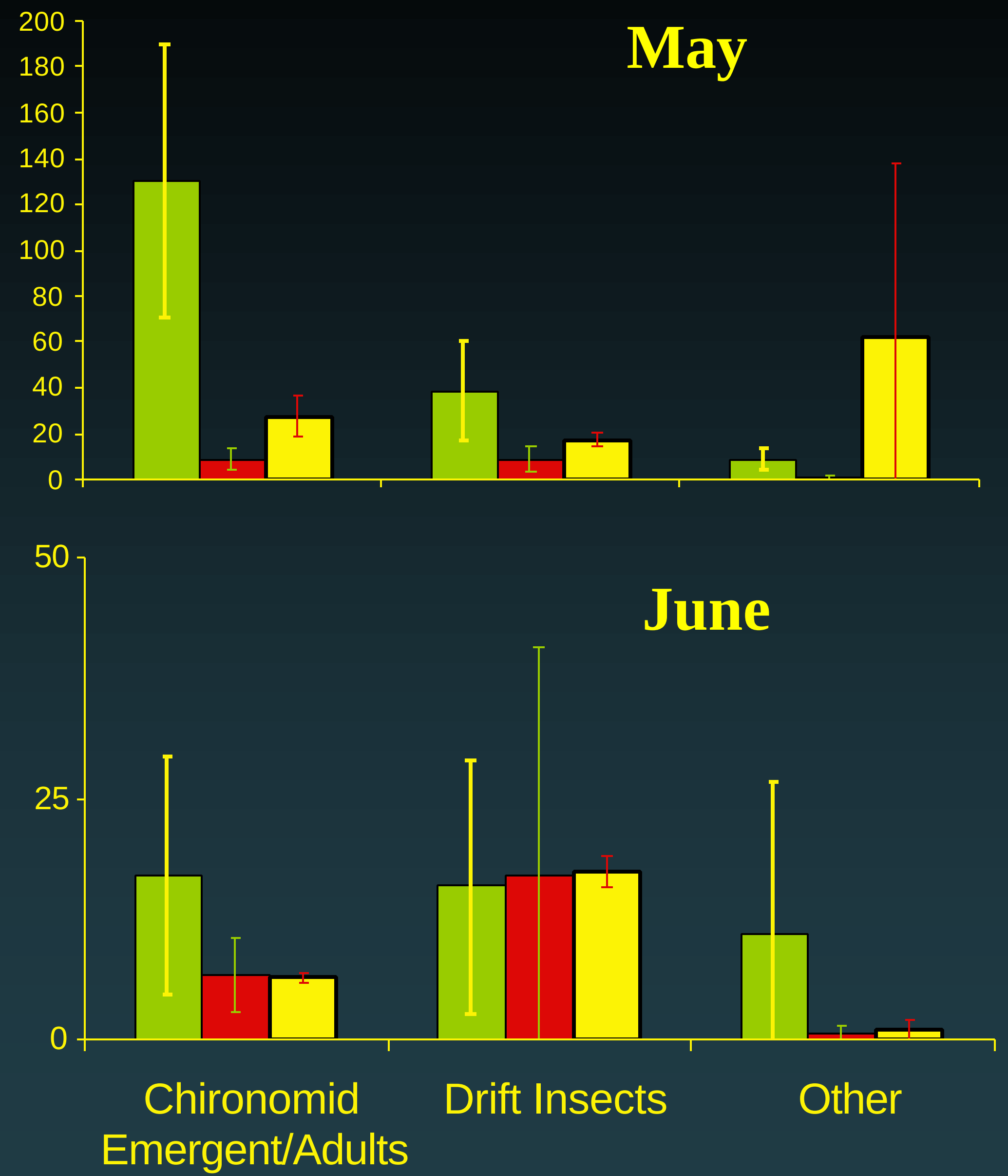
Neuston Taxa Richness
STEDS
MAD
COUL
Mean # of taxa per sample
18
9
0
APR
MAY
JUN

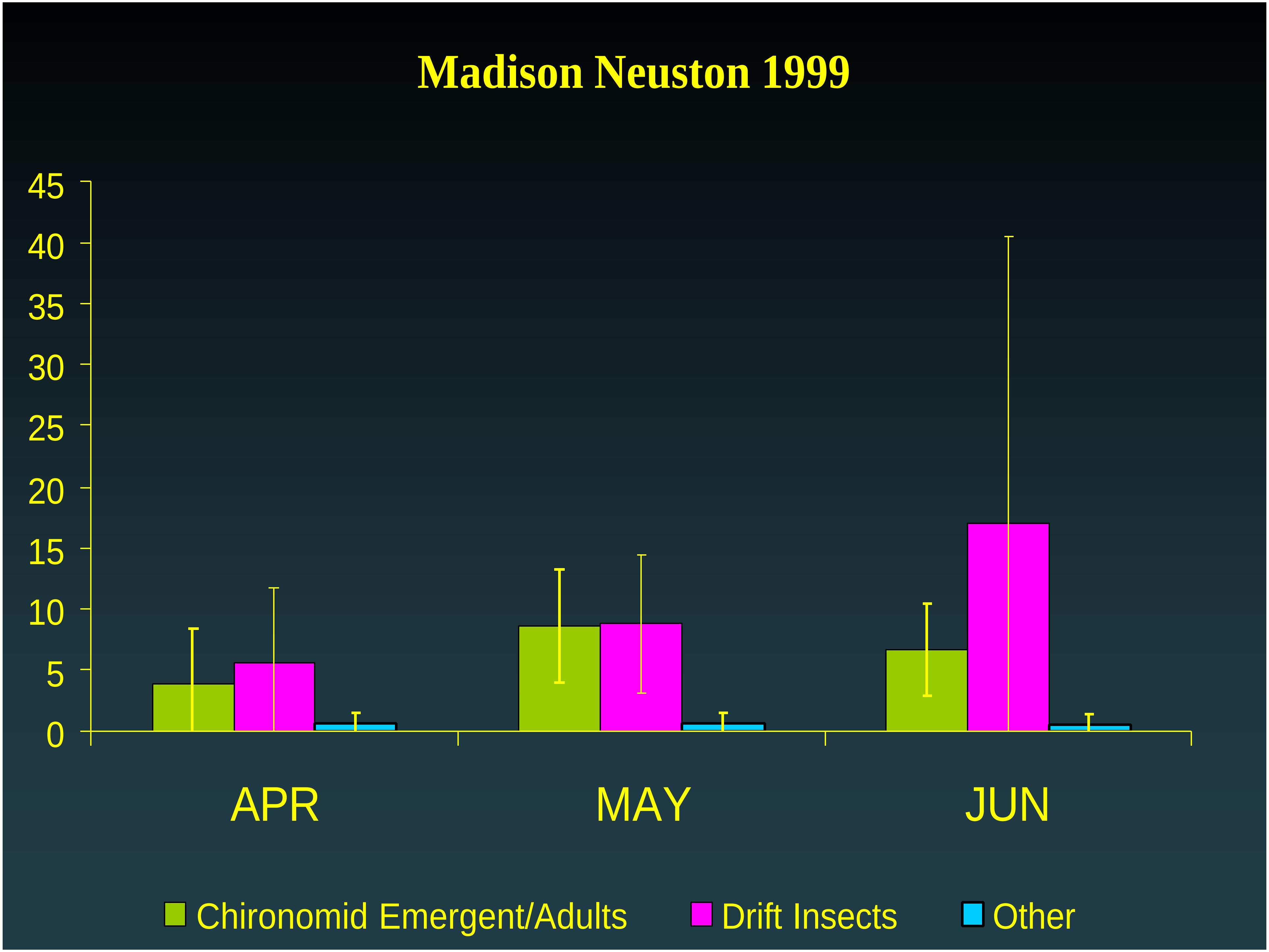
Neuston Relative Density

ST. EDS

MAD.

COUL.

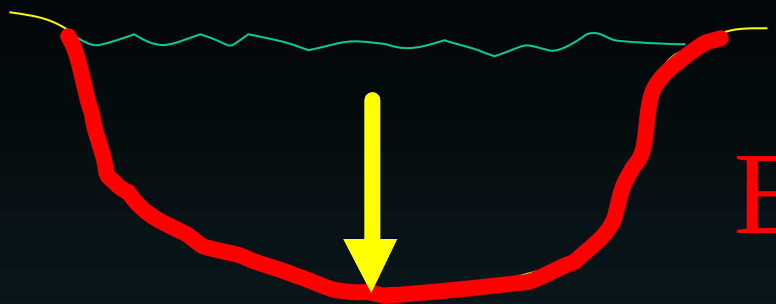




Madison Neuston 1999
45
40
35
30
25
20
15
10
5
0
APR
MAY
JUN
Chironomid Emergent/Adults
Drift Insects
Other

Neuston Findings

- Neuston sampling is appropriate
- Taxa richness greater at less-impacted sites, varies seasonally
- Number of chironomids greatest at our less-impacted sites until June
- Chironomids vary seasonally at St. Eds, but are consitent at Mad. and Coul.



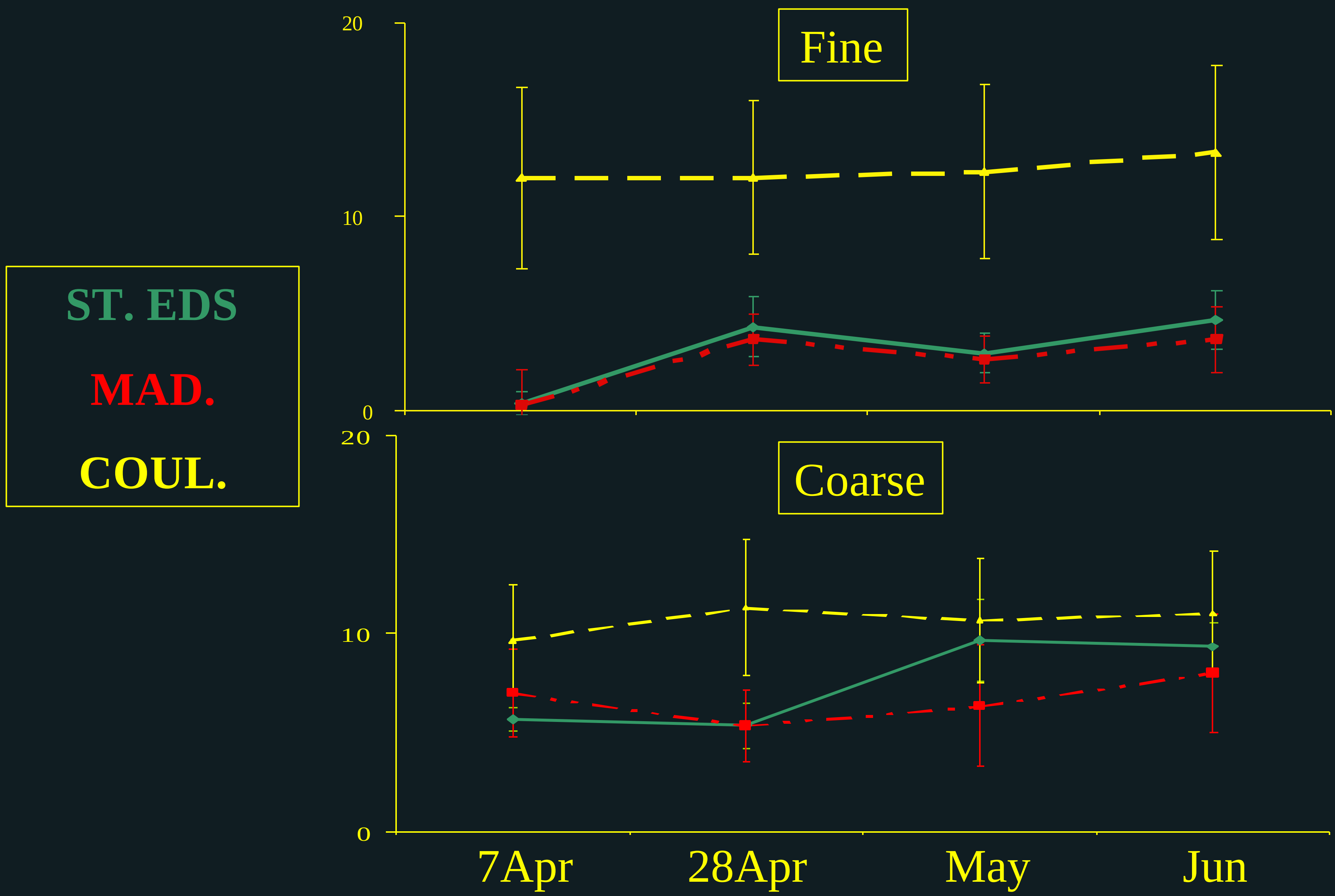
Epibenthic Methods

Sampled every third week

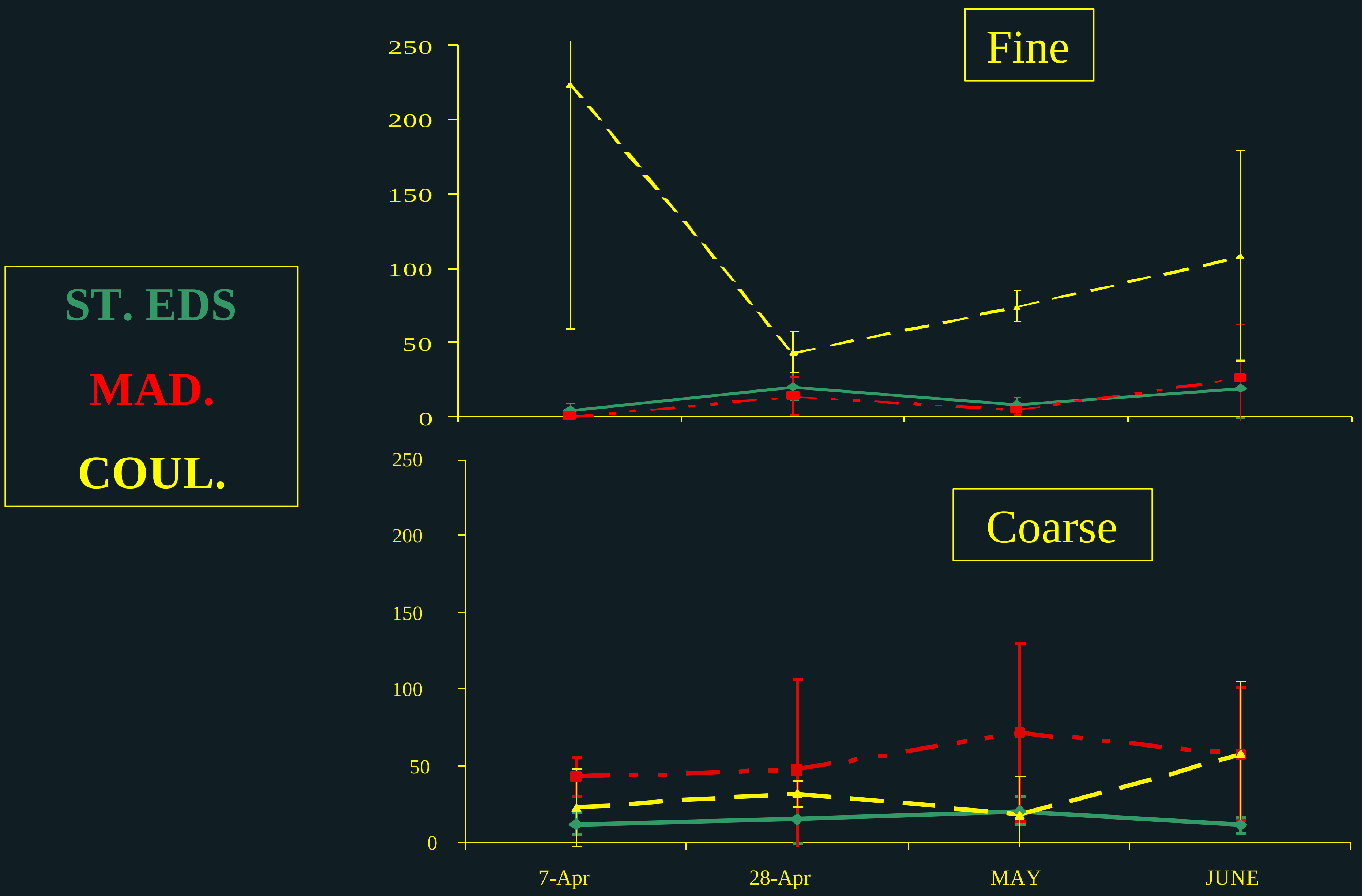
3X, at approximately 1m depth

Over coarse and fine sediments

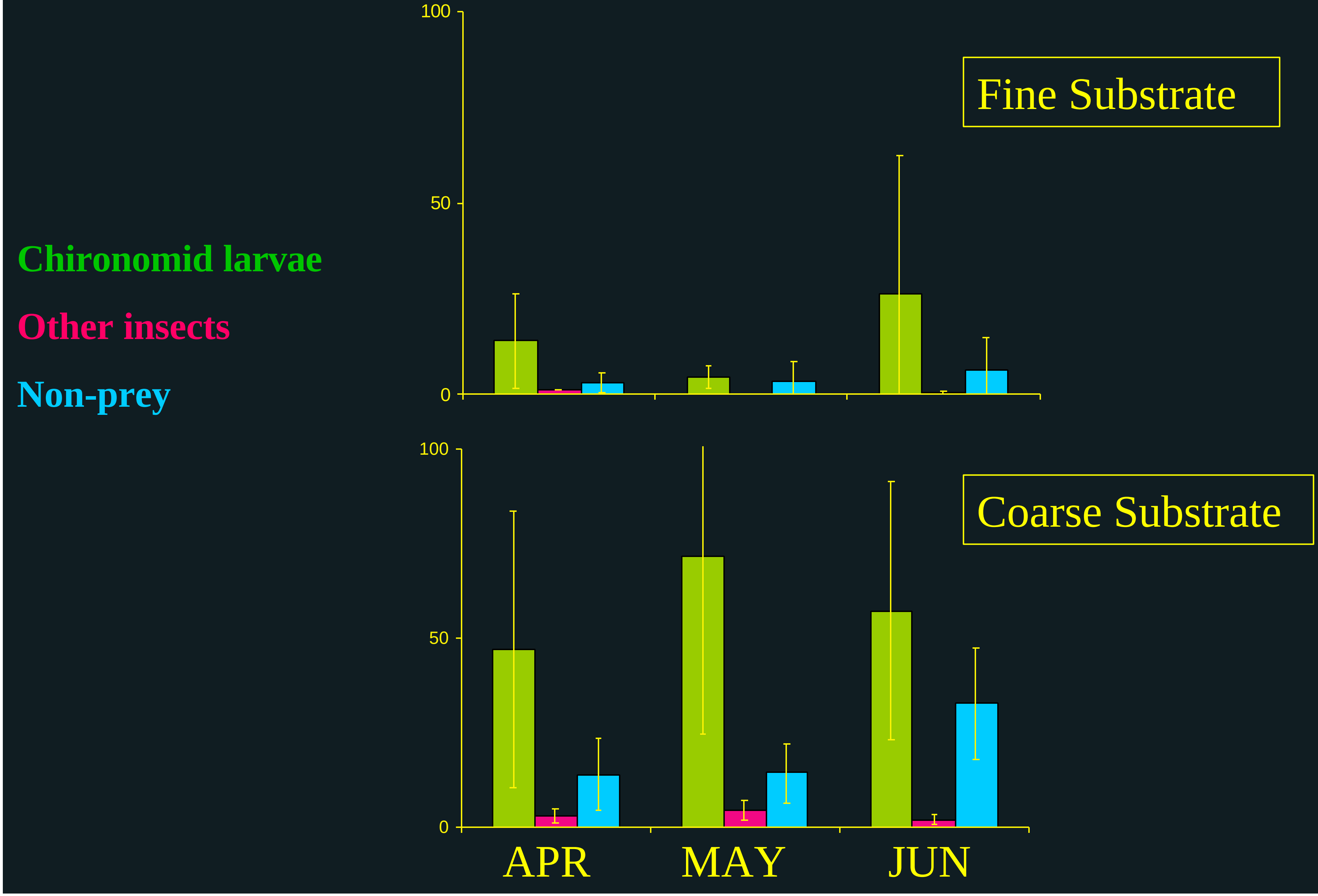
Epibenthic Taxa Richness



Mean Relative Density of Chironomid Larvae (Per sample)



Madison Epibenthos 1999

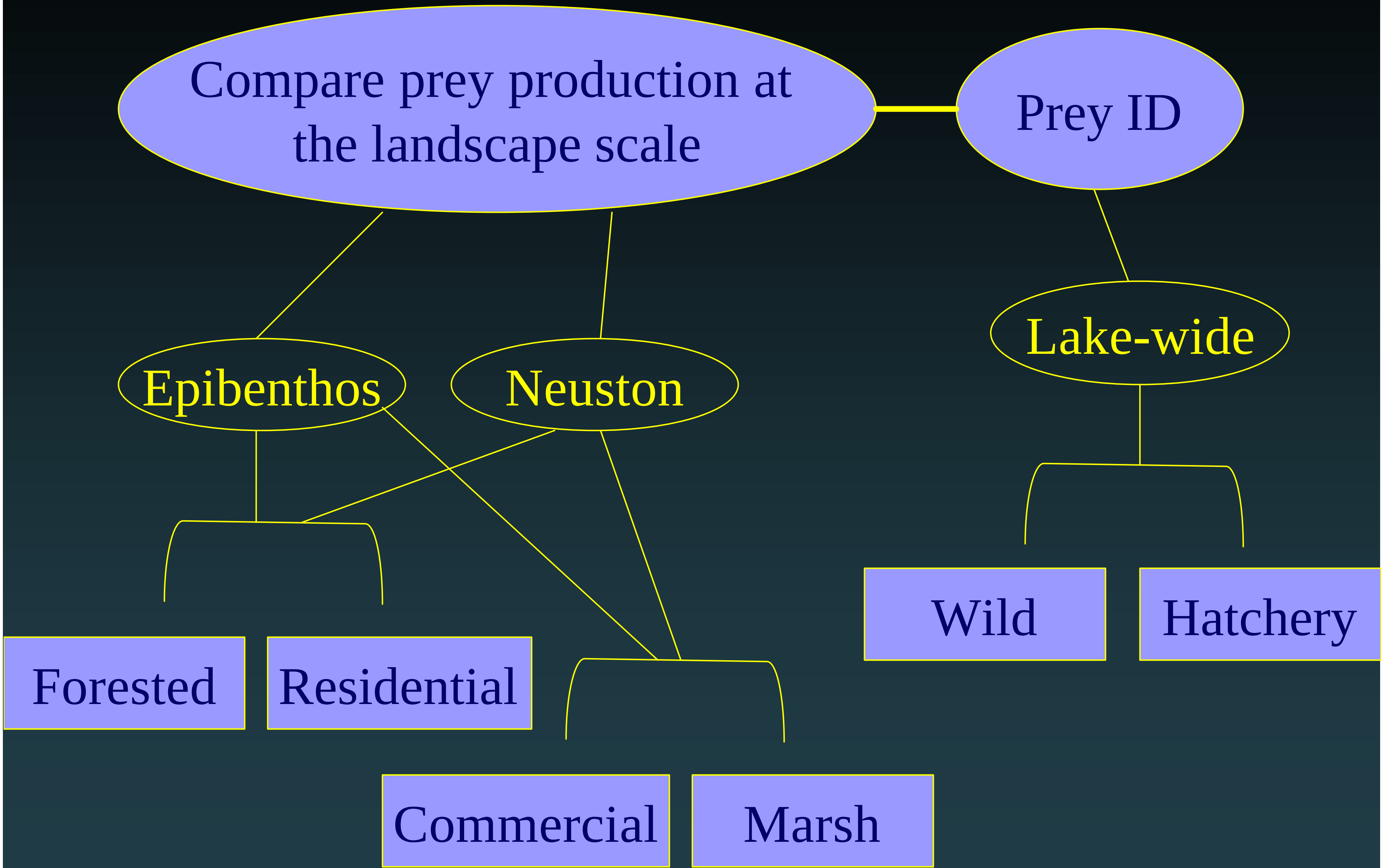


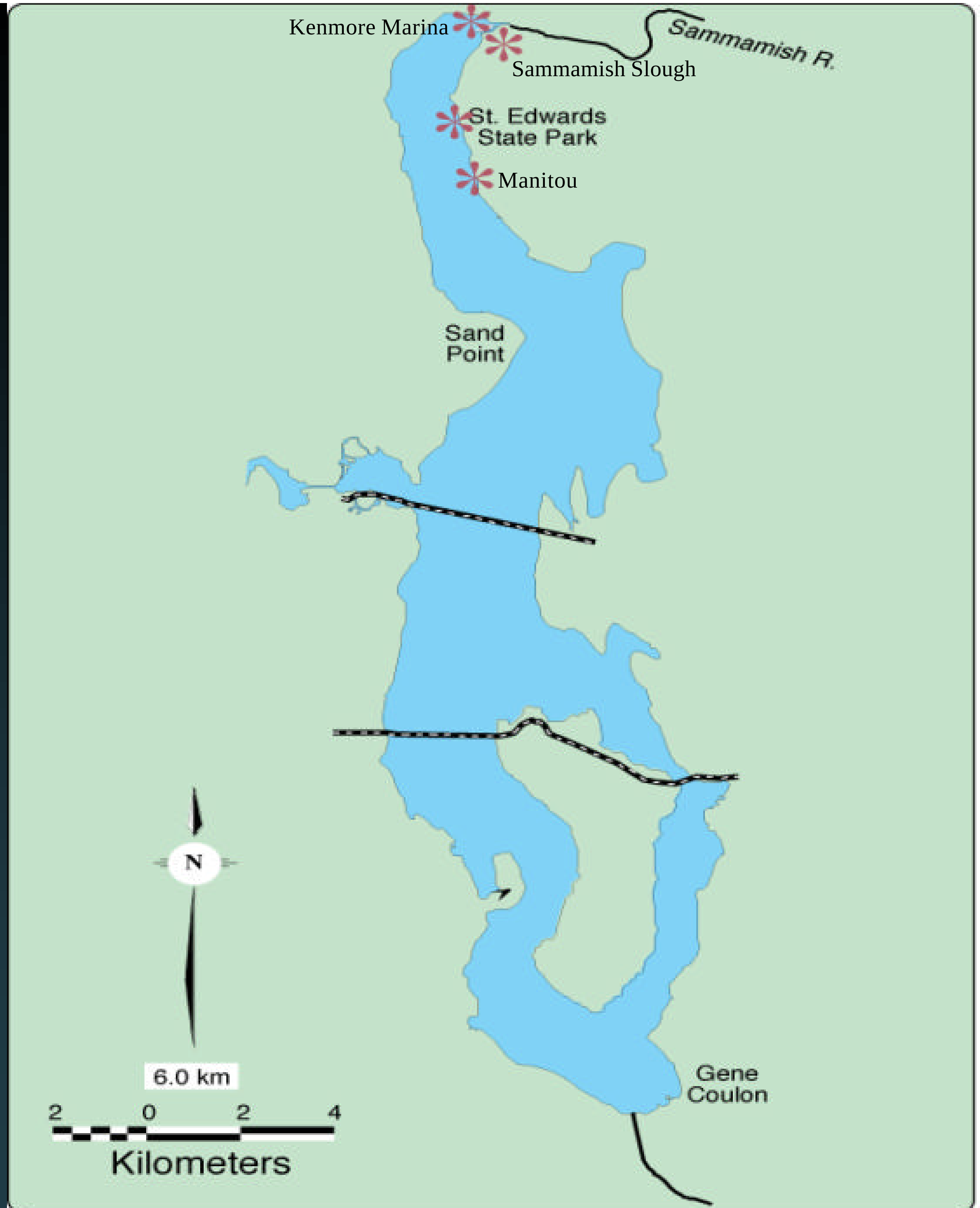
Epibenthic Findings

- Epibenthic sampling is appropriate
- Taxa richness greater at less-impacted sites, but varies with site, substrate
- The number of chironomid larvae are variable between sites, substrates
- Chironomid larvae similar throughout the season at St. Eds and Mad.
- Coarse substrates may produce more chironomid larvae (organic matter?)




Year 2000 Studies





Kenmore Marina
Sammamish R.
Sammamish Slough
St. Edwards
State Park
Manitou
Sand
Point
N
6.0 km
2 0 2 4
Kilometers
Gene
Coulon

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